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ABSTRACT

This study investigates the types and proportions of various types of questions that junior high school biology teachers use during classroom instruction. A beginning teacher's adoption of questioning strategies is also compared with those of experienced teachers. A beginning biology teacher and two experienced teachers participated in the study. Data collection consisted of classroom observation, videotaping, documents, and formal and informal interviews. Results indicate that the types and proportions of questions used by the teachers are somewhat affected by their models of teaching and the stages of instruction. The beginning teacher differed from the experienced teachers with regard to the questioning strategies adopted. The findings suggest that not only can the generative learning model be a useful framework to help science teachers form various types of questions, but it can also be used to improve a teacher's questioning strategy. Contains 25 references. (DDR)

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A Comparative Study on the Use of Questioning Strategies between Beginning Teacher and Experienced Teacher

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Abstract

This study investigated the types and proportions of various types of questions that junior high school biology teachers use during classroom instruction. Beginning teacher's adoption of questioning strategies was also compared with those of experienced ones. The qualitative research method was employed herein. A beginning biology teacher and two experienced teachers were asked to participate in this study. Data collection consisted of classroom observation, videotaping, documents, and formal and informal interviews. In addition, this study applied the "Generative Learning Model" (Osborne & Wittrock,1985) as the theoretical framework to analyze the types and proportions of questions that the three participating teachers used in each stage of instruction. The constant comparative method was also used to analyze the data. The results show that types and proportions of questions used by the teachers are somewhat affected by their models of teaching and the stages of instruction. In addition, the beginning teacher differed from the experienced ones concerning questioning strategies that they adopted. From the results, we recommend that the "generative learning model" not only can be used as a useful framework to help science teachers forming various types of questions, but also can be used to improve teacher's questioning strategy as well.

Introduction

Teachers who use questioning strategies in their teachings usually hope to achieve some goals, such as arousing students' interests and curiosity, fostering students' thinking levels to cause the construction of their concepts, evaluating students' learning degrees, promoting students to participate in discussion actively, contributing to the thinking and learning in the process of "answering questions" (Kerry, 1982). By asking questions, teachers anticipate to guide students' mental activities and to make students think and learn more deeply.

According to 1996 National Science Education Standards, inquiry into authentic questions generated from student experiences is the central strategy for teaching science. Effective classroom questions promote relevance, encourage ownership, help students interpret their observations, and link new learning to what students already know (Deal & Sterling, 1997).

It is obvious that teachers should use effectively questioning strategies in their lessons to stimulate students thinking and learning. However, it was reported that the central focus of all teacher questioning activity appeared to be textbook. Teachers appeared to consider their job to be to see that students have studied the text. Similarly, teachers questioning styles are also textbook-oriented. However, research on questions of the textbook finds that there was a greater proportion of lower-level questions than higher-level questions in these books (Shepardson & Pizzini, 1991). This probably leads to students functioning at lower cognitive levels. In addition, the traditional roles which teachers play in the classroom are often regarded as "the information-giver." They are the center of the classroom learning, and their abilities of class management and clarification are especially emphasized. This type of teaching requires students to recall data or facts rather than to do higher-order thinkings.

It seems that teachers' questioning behaviors do not match educational objectives. Why is it occurred? It is a complex question and might not have a simple answer. However, if science teaching is concerned about helping students to become independent thinkers and

scientifically literate citizens, we need to provide opportunities that allow students actively involve their learning and less teacher control in classes. This means a shift in teacher role from an information-giver to a facilitator, and the teacher should be a guide of the learning process. Central to this shift in teacher role are the types of questions and strategies that teachers ask and use (Blosser, 1998).

Most researches in the past on questioning in the classroom primarily focused on describing types of question and teacher's questioning behavior on students' achievement. There is a few studies on the questions and asking strategies that can help students construct new knowledge effectively. Recent researches on science education pay much attention to the theory of constructivism. Constructivism suggests that the core of students' learning process lies in their using related knowledge to devote themselves to the perception of experience and the active construction process. Osborne & Wittrock(1985) further suggest that learning can be considered as a generative process. As for comprehending scientific concepts, the activity of generation is the basic cognitive process of comprehension. Therefore, there is a need to reexamine what and how questions teacher asked can facilitate students to construct and generate concepts from a constructivist perspective.

The purpose of this study, therefore, was to explore the types of questions, based on the generative learning model (Osborne & Wittrock,1985), which junior high school biology teachers form while they teach. Furthermore, the questioning strategies which the beginning and experienced teachers used in the class were compared.

Literature Review

Research on questioning in the classroom

Questioning remains one of the most influential teaching strategies in the classroom because its potential in stimulating thinking and learning. Early research on questioning conducted before 1950s primarily focused on describing teacher questioning behavior.

Results uniformly support the finding that questions stimulating memory and recall were the type being emphasized in classrooms. Around 1970 a new activity on teacher questioning began. The emphasis in this research was on identifying specific questioning levels and skills that have impact on pupil growth. A major concern in 1980s was the impact of teacher's questions on pupil learning as measured by achievement tests (Trowbridge & Bybee, 1986).

Today, constructivism theory is widely accepted in the field of science education (Tobin& Tippins,1993). The impact of constructivism on teaching and learning has changed researcher's focusing on what questionings affect on the student cognitive processes and on how to improve teacher's questioning strategy to mediate students' learning. There is increasing studies investigating on what types of questions may benefit student's learning; on how to increase pupil's forming and generating questions, and on how to improve teacher's questioning strategy. The following will discuss these issues.

Research on what types of questions and on questioning strategies that may benefit student's learning

When Tobin, Tippins, and Gallard(1994) looked back on influences which "oral interaction" teaching strategies have on science learning, they assumed that teachers should stimulate the cognitive process needed in learning by various strategies.

Identifying specific questioning levels and skills that have impact on pupil growth has been a major concern since 1970s. It is found that the higher levels, open-ended, and divergent questions are more desirable because answering them involves more critical and creative thinking and it indicates a better understanding of the concept. For example, Soled(1994) presents a study of four different teaching strategies dealing comparing lower-level questions with higher-level questions and comparing feedback correctives with no feedback correctives. The result shows that the lowest levels of achievement were in the class with low-level questions and no feedback correctives.

From the perspectives of cognitive science, questioning may increase student's selective attention, cognitive restructuring. Leonard(1987) reports on a study to determine the effects of the presentation of questions inserted into texts for students in introductory biology. Results indicated that students reading the text with questions at the beginning of the paragraph scored significantly higher on achievement tests than the students reading without questions. Holliday, & Benson(1991) reports that adjunct questions used can increase students' attention on specific columns in a modified science chart, and improve student achievement on a test measuring learning of content. In another study, Appleton(1993) presents a learning model for science education and describes teacher interventions derived from the model can produce student cognitive restructuring.

Research on how to increase student's questioning

From a view point of constructivim, encouraging student to ask questions during learning can help them understand science. Therefore, it is important for teachers to increase student's questioning.

Cratsley(1991) presents the idea that, to improve secondary science, students must be taught to use the activities of science: questioning, information gathering, hypothesizing, testing and conveying, and confronting current issues and problems in science. The author concluded that the science activities can be used to help students understand science.

Allison & Shrigley(1986) determined if the number of operational questions asked by fifth- and sixth-grade students (N=72) increased by teacher modeling or by practice at writing such questions. One finding is that students experiencing two types of teacher modeling asked more operational questions than students in a control group.

Zielinski & Sarachine(1990) presented six activities that include discrepant events and questioning, divergent thinking, dilemma discussions, and drawing objects from symbols. They suggested that the activities help to promote critical and creative student thinking.

Pizzini & Shepardson(1991) investigate student questioning within the Search, Solve, Create, and Share (SSCS) problem solving instructional model. The results suggest that the SSCS problem-solving instructional model increases student questioning in the presence of the teacher (n=22) when compared to a teacher-directed laboratory instructional model.

There are some other studies discussing about how to generate questions to help teachers themselves and to increase students asking questions. Gilbert(1992) suggests that teachers should consider which questions to ask as a part of instructional preparation. A teacher should use a taxonomy for a template when writing questions to ensure that diversity and critical thinkings are involved. Langrehr(1993) discusses some scaffolds or prompts for helping students to ask themselves better questions about science topics. Hinton(1994) presents a series of lessons that use Bloom's taxonomy of educational objectives to teach students the various levels of knowledge and how to form questions that address each level.

Research on how to improve teacher's questioning strategy

The ability of the teacher to ask questions to motivate and to stimulate student's thinking and learning is basic to inquiry teaching. An instructor should plan his or her questions before the class but remain flexible and adapt his or her instruction as dictated by student interaction.

Research shows that teachers can be effectively trained to raise the cognitive emphasis of their questions. Crooks, & Gifford(1992) investigated whether the use of videotaped models demonstrating effective teaching strategies in an elementary science lesson would promote increased use of effective questioning strategies among preservice teachers (n=38). Results show that the use of the videotaped teaching models increased the use of high-level, divergent, convergent with high-level, and divergent with high-level questions in the preservice teachers' teaching performance.

Another field of study on improving teacher's questioning strategy is wait time. Atwood & Wilen(1991) defines wait time as the time teachers wait for answers from students

after asking a question. They maintain that increasing wait time can stimulate reflective thinking and student involvement. Review the research literature on wait time studies in science education, finds that student responses improve and participation expands with increased wait time. Riley(1986) investigated effects of varied wait-time durations and cognitive questioning levels on student achievement. Analyses of achievement results (using 30 preservice elementary teachers and 129 students) indicated significant differences attributable to teacher wait-time and cognitive questioning level. Tobin(1984) investigated changes that occurred in sixth- and seventh-grade teacher and students discourse when teachers endeavored to implement extended teacher wait-time in a sequence of seven lessons related to probabilistic reasoning. Results indicated that teacher wait-time increased from an average of 1.9 to 4.4 seconds during the lesson sequence.

Comparison between experienced teacher and novice teacher on the behavior of teachings

There are some differences on teachers' teaching behaviors between experienced teacher and novice teacher. Kumar, & Hofwolt (1992) used instructional behavior items on the Elementary Science Instruction Observation Instrument to compare preservice elementary science teachers (n=12) to exemplary elementary science teachers (n=5). They found significant differences on the teachers' behaviors including the use of communication of objectives, scientifically correct representations, rate of use of questioning behaviors, and providing hands-on activities. Westerman (1991) compared teachers' decision-makings on their teachings before, in, and after the classroom between novice and experienced elementary teachers. Results indicated that the experienced teachers paid much attention to student's learning than the novice teachers did. The experienced teachers also have more integrated knowledge on the teachings.

Conclusion

From the above discussion, several tentative conclusions can be drawn concerning questioning in the classroom:

1. The impact of constructivism on teaching and learning has changed researcher's' focusing on how to improve teacher's questioning strategy to mediate students' learning.

2. Questioning can help students to do critical thinking, to recall knowledge and information, to increase involvement, and to improve selective attention and cognitive restructuring.

3. Teachers can be effectively trained to improve their questioning strategy.

4. There are differences on teacher's questioning strategies of between experienced teacher and novice teacher.

Design and Procedures

Subject

Three biology teachers were invited to participate in the study. One beginning teacher, Miss Lou, and two experienced teachers, Miss Lun and Miss Lin. They all taught 7th grade biology.

Miss Lou has a bachelor degree in biology and has two years teaching experience already. She said that she likes to teach biology and frequently reflects on her teaching. However, Miss Lou mentioned that she has less confidence in her questioning skill. Miss Lou's class has about 40 students, half of students are male and half are female.

Miss Lun, has a bachelor degree in biology and had entered an inservice training program about graduate level. She has 10 years teaching experience and likes to teach biology because it is easy, interesting, and students like to learn. Miss Lun said that she used to teach biology in a traditional way. However, she accepts the idea of constructivism after finishing her inservice program, and takes it as a referent to her class. Miss Lun mentioned that she has changed her way of teaching to wait and to listen what students' say.

She was interested in questioning strategy when she was invited to participate the study. Miss Lun believes that teachers should generate good questions and should assess its effectiveness during the lesson. She is confident in her questioning skill. In Miss Lun's class, male and female students is about 2 to 1. Very often, the male students dominated the class.

The other experienced teacher, Miss Lin, also has a bachelor degree in biology and did the same inservice training program as Miss Lun had. She has 11 years teaching experience and is sensitive, active, and confident in her teaching and questioning skill. Miss Lin also accepts the idea of constructivism and attempted to use it in her classes. She has used "problem-oriented cooperative learning" teaching strategy for three years. Miss Lin believes that questioning can help students thinking and learning, therefore, teacher should use it no matter what teaching strategies used. She mentioned that teachers should pose different types of questions with different teaching strategies. In her "cooperative learning" teaching strategy, she likes to pose more integrated questions. In Miss Lin's class, the students always sit in 6 groups. In each group, they used to have 3 males and 3 female.

Research procedure and Data Collection

The qualitative research method was used in this study. Based on the concerns of not intervening school curriculum and the teachers' class schedules, the researchers decided to be complete observers (Bogdan & Biklen, 1992). The study was conducted in the three teachers' 7th grade biology classes in three different middle schools of the central Taiwan. The researcher had no interventions with their teaching plans, teaching activities, and evaluation.

The data collection includes classroom observations, videotaping, documents, and formal and informal interviews. The 14 classes of Miss Lou, 22 classes of Miss Lin, and 20 classes of Miss Lun individually were observed, videotaped, and transcribed. The formal interviews were conducted in the beginning and the end of the semester to investigate the teachers'

perspectives on biology teaching and questioning. The following are examples of the interview questions:

1. What do you think about the biology teaching? and how your students learn biology?

2. What do you think teacher's questioning on student's learning?

3. Can you describe how you use questioning strategy?

To answer questions raised by classroom observations, the post-class informal and formal interviews were conducted after each classroom teaching for clarifying what and why the questions were asked by the teachers during the lesson. In addition, what they think about those questions and students' responses for data triangulations.

Data analysis

The data obtained were analyzed to answer the research questions. The data consist of classroom observation notes, videotape transcripts, interview protocols, and documents. The constant comparative method (Bogdan & Biklen, 1992) was used to analyze data for finding categories of teachers' questions, and for identifying patterns that evolved from questioning.

From the above purpose and procedure, a systematic method was inductively developed and was used to analyze the teachers' questions. The method is based on time series of teaching during the class go on. We divided a class into three periods: initiating concepts, developing concepts, and integrating concepts. Therefore, a series of questions posed by the teachers in the concept-developing process as a unit to analyze.

In the period of initiating concepts, the main focus is on questions teachers ask to inspire students to learn a new concept. In the period of developing concepts, the question types which teachers use to help students linking their previous knowledge with new concepts were analyzed. At last, in the period of integrating concepts, the researcher emphasized how teachers use questions to help students integrate previous associations, and then finish teaching a concept. The types and proportion of questions the three teachers used in each stage were individually induced and concluded.

Findings

From the constructivist view of learning, Osborne & Wittrock(1985) suggest that learning is considered as a generative process. Therefore, the core of students' learning process lies in their using related knowledge to devote themselves to the perception of experience and the active construction process. The purpose of this study, based on the "generative learning model," was to explore what questions teachers asked can facilitate students to construct and generate concepts from a constructivist perspective. Furthermore, the difference on the questioning strategies adopted by the beginning and experienced teachers were compared. In the following, we begin with a discussion of types of questions the teachers asked in their classroom and then move to the strategies they adopted while questioning.

I. The types of questions posed by the teachers

The data of transcripts from classroom videotaping consist 14 classes of Miss Lou, 22 classes of Miss Lin, and 20 classes of Miss Lun individually. From those of transcripts, it is found that most of Miss Lou's and Miss Lun's teachings are traditional didactic teaching methods, although Miss Lun's class is more active and the interaction between the teacher and the students are higher. On the other hand, Miss Lin taught biology mostly with cooperative learning. In her class, students are assigned to a small group with a special task to learn. The classroom climate is fairly active and cooperative.

Furthermore, the questions posed by the three teachers in their classes are various, and those questions can be divided into three groups such as "perception", "association", and "integration" based on the generative learning model. The "perception" types of question include questions that can inspire and motivate students to learn a new concept. The "association" type of question includes questions that can help students link their previous

knowledge with new concepts. The "integration" type questions include questions that can help students integrate previous associations, and then finish teaching a concept.

In addition, the questions posed by the teachers can be further divided into several subtypes. For example, the "perception" type question that can inspire student's perceptions with "pictures" is defined as "P1" question. The question related to everyday event is defined as "P2" question. Finally, the "P3" subtype question is the question that can inspire students' perception by using concrete object or student's self body. Some examples of "perception" type and subtype questions are discussed below:

P1 question
T: What do you see about the picture on page #21?
S: A "cell."

P2 question
T: What did you eat at lunch?
S: Rice, bean, pork, chicken,...

P3 question
T: Everybody, look at your neighboring classmate, and what structures do you see at his or her body?
S: Head, face, hands, legs,...

Accordingly, the "association" type of question can be divided into two groups: A*l* (associations with long-term memory) or As (association with the experience of sensory perception). Furthermore, the A*l* type questions are divided into subtypes of A*l*1 (association by asking question), A*l* 2 (association by repeating questions in quest of other answers), A*l* 3 (association requiring students to list the concerning examples), A*l*4 (association with prior concepts or previous teaching contents), A*l* 5 (association with learners' living experience), and A*l* 6 (association the concrete experience with abstract concepts with "analogy"). On the other hand, the As type questions are divided into subtypes of As1 (association with pictures), As2 (association with cues), As3 (association with the text), and As4 (association with the process and the result of the experiment). Some examples of "association" type and subtype questions are discussed below:

A/ 1 question:

T: Why were the dinosaurs extinct?
S: Because the environment was changed.
T: Any relationship with human being?
S: No.
T: Why not?
S: Because no human then.

A/ 2 question:

T: Why the koala may face an extinction?
S: Sleep all day long.
T: And then? Why they may face an extinction? (Explain more)
S: Walk slowly.
.....

As1 question:

T: Please pay attention to the picture that I draw on the blackboard. What is this?
S: Epidermis.
T: What is its function? (Explain more)
S: protect leaf.
.....

As2 question:

T: If you receive a stimulus, then you will have a response, what connect a stimulus and a response?
S: Nerve.
T: Nerve? It should be a complete system.
S: Nerve system.

Similarly, the "integration" type of question can be divided into two groups: Ir (integration with restructuring), and Is (integration with subsuming). The questions that would cause student's concept conflicts are the "Ir" types, however, those questions, which may lead to learners' successful construction and form "meaningful comprehension" in developing concepts, were separated into "Is" types.

Ir type question can be divided further into five subtypes, such as Ir1 (integrating by comparing two different opinions), Ir2 (integrating using non-example or pointing out the neglected conditions), Ir3 (integrating by repeating questions again or giving restrictions to focus), Ir4 (integrating by using misconception to form questions or use multiple-choice questions), and Ir5 (integrating by adding a new condition and asking students to think again).

Ir1 question:
T: Why people who eat nothing for a protest become weaker and weaker, even shock or die if they insist?
S1: Nutrition is energy. People need nutrition to do exercise. Protested people will shock and die because they lack sufficient nutrition.
T: ... Do you agree with what he said?
Ss: Disagree.
T: What and why do you disagree about?
S2: Minerals and Vitamins are nutrition but consisting no energy.
T: So, whether S1 mentioned "nutrition is energy" is correct or not? Each of you should think about.

Ir4 question:
T: Some students said that chlorophyll absorbs sunlight, then it is breakdown into oxygen and hydrogen. Is this correct or not?
Ss: No, it is breakdown of water.
T: Water or chlorophyll is breakdown?
Ss: Water.
T: (OK) So water is breakdown into oxygen and hydrogen?
Ss: No.
T: Why not? Oxygen goes out and then produces Hydrogen?
Ss: It is not hydrogen.
T: Not hydrogen, then what?
.....

In addition, the Is type questions can be divided into three subtypes, such as Is1 (Integrating the thorough concepts after guiding with a series of sub-topics), Is2 (Integrating associations between two concepts, or making the comparison and contrast), Is3 (integrating by repeating questions to emphasize answers when the developing of concept is finished).

Is1 question:
T: Three Tissues of the leaf can perform the photosynthesis. Who knows?
S1: Guard cell(stomata), and mesophyll.
T: Mesophyll consist of two parts, what are they?
S1: Palisade layer and sponge layer.
T: Right, cells of palisade layer and sponge layer can perform most of plant's photosynthesis.

Is2 question:
T: Can anyone describe the excretory system of our body?
S1: Lung.
T: Lung? Lung is an organ of respiratory system, what wastes it can excrete?
Ss: Carbon dioxide, and water.
T: Is it water?
S2: It is water vapor.
T: Say water vapor is better, What else (of the excretory system)?
Ss: Sweat gland.
T: What does the sweat gland excrete?
Ss: Water and wastes.
T: What kind of wastes?
Ss: Salt, urea, heat.

The above mentioned types and subtypes of questions are shown as Fig. 1.

Types	Subtypes
Perception	P1: Inspiring student's perceptions with "pictures"
	P2: Inspiring student's perceptions with "the events in daily life"
	P3: Inspiring student's perceptions with "the structure of our bodies" or "concrete objects"
Association	
	Al :association with long-term memory
	Al 1: Association by asking questions
	Al 2: Association by repeating questions in quest of other answers
	Al 3: Association requiring students to list the concerning examples
	Al 4: Association with prior concepts or previous teaching contents
	Al 5: Association with learners' living experience
	Al 6: Association the concrete experience with abstract concepts with "analogy"
	As:association with sensory experience
	As1: Association with pictures
	As2: Association with cues
	As3: Association with the text
	As4: Association with the process and the result of the experiment
Integration	
	Ir: integration with restructuring
	Ir1: Integrating by comparing two different opinions
	Ir2: Integrating using non-example or pointing out the neglected conditions
	Ir3: Integrating by repeating questions again or giving restrictions to focus
	Ir4: Integrating by using misconception to form questions or use multiple-choice questions
	Ir5: Integrating by adding a new condition and asking students to think again
	Is: integration with subsuming
	Is1: Integrating the thorough concepts after guiding with a series of sub-topics
	Is2: Integrating associations between two concepts, or making the comparison and contrast
	Is3: Integrating by repeating questions to emphasize answers when the developing of concept is finished

Fig. 1. Types and subtypes of questions posed by the biology teachers based on the generative learning model

II. Comparison on the types and proportions of questions posed between experienced teacher and novice teacher

According to table I, all the three biology teachers can pose different types of questions in their teachings. However, the types and the proportions of questions used by the experience teachers are more various than the beginning teacher did.

In the period of initiating concepts, it reveals that proportions of question types posed by the teachers during the period of initiating concepts are fairly affected by styles of teaching. In traditional lecture teaching, the teachers mostly use "perceptive" questions to inspire students. For example, Miss Lou posed 49.9% of questions regarding the "p" type questions, and Miss Lun did about 59.2%; but in the cooperative teaching, the teacher frequently poses "integrative" questions. Miss Lin, for example, posed about 32.6% "Is" type questions.

Second, in the period of developing concepts, the types and proportions of questions posed by the three teachers are very similar. The teachers mostly posed the "Al" type of question. For example, Miss Lou did about 57%, Miss Lin did about 58.2%, and Miss Lun did about 53.8% individually. However, there are two greater differences between the beginning teacher and the experienced teachers in the types of questions they asked. The first difference lied in A/ l type question. The proportion of "A/ l" type of question posed by Miss Lin is 27%, and by Miss Lun is 22.8%. That is, two experienced teachers particularly emphasized whether students' answers were clear enough to express their own ideas and to let other students understand, which explained why the two teachers often asked students' questions. Second, the experienced teachers were good at provoking students' concept conflict by asking them questions. They asked more questions regarding the "Ir" types, i.e., Miss Lin asked about 26.5% and Miss Lun asked about 21%, which aimed to stimulate students to think more deeply, to elicit misconception students might have, and to guide them to "reconstruct" their previous knowledge.

Finally, in the period of integrating concepts, the beginning teacher integrates concepts herself mostly, that is Miss Lou used up 70% of time to make a conclusion by herself; on the contrary, the task of integrating concepts was still done by students themselves, after the experienced teachers helped students make some associations by asking students' questions, the most of which was "Is" types, for example Miss Lin posed 59.5% questions regarding "Is" type and Miss Lun did about 59%.

Table I. Proportions of various types of questions posed by the biology teachers in different stages of their teachings

Teaching stages	Types of question	Miss Lou		Miss Lin		Miss Lun	
		% of subtype questions	total %	% of subtype questions	total %	% of subtype questions	total %
Concept Initiating Stage	P	lecturing P1 (17.6)	23.5	lecturing P1(11.5)	2.0	- P1 (29.6)	-
		P2 (17.6)	49.9	P2 (7.7)	21.2	P2 (16.0)	59.2
		P3 (14.7)		P3 (2.0)		P3 (13.6)	
	A/	-		A/3 (2.0)		-	
		A/4 (20.6)	20.6	A/I4(11.5)	13.5	A/4 (16.0)	16.0
	As	-		-		As1 (4.5)	
		As3 (3.0)	3.0	As3 (5.8)	17.3	As3 (4.5)	15.8
		-		As4 (11.5)		As4 (6.8)	
	Ir	-	-	Ir4 (13.5)	13.5	Ir4 (2.2)	2.2
	Is	Is1(3.0)	3.0	Is1 (3.8)	32.6	-	6.8
		-		Is2 (28.8)		Is2 (6.8)	
			100.0		100.0		100.0
Concept Developing Stage	A/	A/1(14.1)		A/1(27.0)		A/1(22.8)	
		-		A/2(1.8)		A/2(3.6)	
		A/3(4.0)	57	A/3(4.1)	58.2	A/3(6.1)	53.8
		A/4(28.2)		A/4(20.0)		A/4(18.3)	
		A/5(10.7)		A/5(3.5)		A/5(1.0)	
		-		A/6(1.8)		A/6(2.0)	
	As	As1(17.4)		As1(9.4)		As1(8.1)	
		As2(8.1)		As2(0.6)		As2(1.5)	
		As3(3.4)	29.6	As3(4.1)	15.3	As3(9.2)	22.4
		As4(0.7)		As4(1.2)		As4(3.6)	
		-		Ir1 (3.5)		-	
	Ir	Ir2 (6.7)		Ir2 (10.6)		Ir2 (8.6)	
		Ir3 (2.7)	12.1	Ir3 (2.4)	26.5	Ir3 (4.1)	21.0
		Ir4(2.7)		Ir4(8.8)		Ir4(7.1)	
		-		Ir5 (1.2)		Ir5 (1.2)	
	Is	Is1(1.3)	1.3	-	0	Is1(0.5)	3.0
		-		-		Is2(2.5)	
			100.0		100.0		100.0
Concept Integrating Stage	As	conclusion	70.0	conclusion	35.1	conclusion	35.9
		As2(3.3)	3.3	As2(2.7)	5.4	-	5.1
		-		As3(2.7)		As3(5.1)	
	Ir	Ir4(3.3)	3.3	-	0	-	0
	Is	Is1(20.0)		Is1(51.4)		Is1(33.3)	
		Is2(3.3)	23.3	-	59.5	Is2(5.1)	59.0
		-		Is3(8.1)		Is3(20.6)	
			100.0		100.0		100.0

Data from transcripts of classroom videotaping for 14 classes of Miss Lou, 22 classes of Miss Lin, and 20 classes of Miss Lun individually.

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Discussion and Conclusion

Effective classroom questions help students interpret their observations, and link new learning to what students already know (Deal & Sterling, 1997). According to the "generative Learning model," the learner will not passively accept the message but actively construct schema for the incoming message, and use it as a basis of judgment and inference to construct new knowledge. Therefore, teachers should be the mediator of learning, who ought to "ask questions" frequently to stimulate the cognitive process that is needed while learning.

Gilbert(1992) suggests that teachers should consider which questions to ask as a part of instructional preparation. A teacher should use a taxonomy for a template when writing questions. Therefore, finding a framework for generating questions is important for teachers. In the past, some investigators suggest using Bloom's taxonomy of educational objectives to teach students the various levels of knowledge and how to form questions that address each level (Hinton,1994). From the findings of this study, the questions posed by the three teachers in their classes are various, and those questions can be divided into three groups- "perception", "association", and "integration", based on the generative learning model (Osborne & Wittrock,1985). We suggest that this systematic method, based on the generative learning model, can be used as a useful template for science teachers to generate questions.

Furthermore, based on the generative Learning model, teachers must pay great attention to students' prior knowledge when forming questions, and the ways of organizing questions should correspond to the ways students developing their concepts. Therefore, teachers should ask students some questions in appropriate occasion in view of students' response. Teachers are also supposed to inspire students' selective perception, and enable students to associate the new messages with their sensory experience and their long-term memory. All the above mentioned will be able to help students to construct their new knowledge

successfully. However, Kumar & Hofwolt(1992) pointed out that there is a significant difference on questioning behavior between novice teacher and experienced teacher. Westerman(1991) also pointed out that experienced teachers have more integrated knowledge and pay much more attention to what students have learned. In this study, we have a similar finding. All the three biology teachers can pose different types of questions in their teachings. However, the types and the proportions of questions used by the teachers are some what affected by their model of teaching and stages of instruction. In addition, the types and the proportions of questions posed by the experience teachers are more various than the beginning teacher did. The two experienced teachers allow students to express their own ideas and clarify their answers, and help students to integrate concepts by themselves.

From the results of the study, we recommend that the "generative learning model" not only can be used as a useful framework to help science teachers forming various types of questions, but also can be used to improve teacher's questioning strategy as well.

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